Easily missed fractures of extremities

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It is well documented that subtle fractures are often missed on initial radiographs when interpreted by junior doctors and sometimes by senior medical staff. Missed fractures can lead to significant morbidity in all age groups, particularly in children and young adults. With the increasing population and the increase in sporting activities, the volume of patients attending Accident and Emergency has increased with resultant increase in the patients referred to Radiology Departments. This indirectly increases chances of missed fractures.

Missed fractures are often unapparent or demonstrate subtle abnormalities on initial radiographs. Studies have shown that these fractures are often missed in emergency settings, especially in the late hours or weekends and by newly-trained doctors. Missed fractures contribute to a large extent of malpractice claims.

Plain radiographs remain important diagnostic tool in the evaluation of extremity trauma. Routine use of comparison films of the contra-lateral asymptomatic side is not appropriate, although it may be useful in the evaluation of suspected physeal injuries or when a normal variant considered. Digital imaging helps in reducing the repeat radiographs. Picture archiving and communication system reduces the overall rate of misdiagnosis.

Other extent of missed fractures are bone bruises or contusions or minor cortical breaks, which are not apparent on plain radiographs. These are often apparent on other imaging modalities like MRI, isotope scans and CT scans. MRI and CT are useful in these settings due to their ability in contrast resolution and multiplanar capabilities. In addition, MR imaging has the capability to detect internal derangements of cartilage or ligament injuries.

Easily missed fractures of the upper extremity

Carpal bone fractures can be very subtle and a missed fracture/delayed diagnosis can lead to malunion, chronic pain and morbidity. Among the carpal bones, the scaphoid is most notorious. Initial radiographs may not reveal a scaphoid fracture and are usually imaged and assessed 7-10 days following the trauma. If a fracture is clinically suspected but not radiographically detected, a bone scan/CT scan or a MRI scan is diagnostic.

Triquetral fractures from dorsal avulsion at the attachment of radiocarpal ligaments are best seen on lateral views. Distal radial fractures and fractures of the metacarpals/phalanges in children may show only slight angulation. Avulsion fractures of the phalanges may be mistaken for accessory ossicles.

Buckle (torus) fractures in children are very common, where the trabeculae across the fracture line are compressed and the cortex bulges outwards – unilateral or bilateral. In other cases, the fracture shows only cortical angulation along one side of the bone – “the angled buckle fracture.” These fractures are very subtle and are easily missed. They occur through the metaphyses just adjacent to the epiphyseal plate.

Angled buckle fractures are usually isolated, subtle and frequently missed. The elbow, wrist and ankle are prone to these types of fractures. In the elbow, the proximal radius is most commonly involved, followed by the distal humerus. At the wrist, the radius is again the most frequently involved. Even more frequently missed angled buckle fractures are fractures involving the small bones of the hand.

Scapular fractures are uncommon and hence easily missed. Care should be taken not to confuse ossification centres for fractures. Subluxation at the AC joint may need an AP view with 15 degree cephalad angulation or may need opposite shoulder view for evaluation or may need stress views. Undisplaced greater tuberosity fractures can be missed easily.

Fractures at the elbow are common in children and may show only subtle signs. Look for anterior and posterior fat pad sign, disruption of the anterior humeral line, radiocapitellar line, avulsion of the medial and lateral epicondyles.

Points to remember

Angled buckle fractures of the extremities in children are common and less likely to be missed if one is aware of the common sites that these fractures occur.

Secondary signs are important for evaluation of elbow trauma.

Bone scan/CT/MRI scan is indicated if fracture line is not visible on plain films.

Early reporting system in place is essential in reducing the morbidity.

Easily missed fractures of the lower extremity

Ankle radiographs account for approximately 10% of all lower limb requests, and nearly all include a foot radiograph, indicating lack of awareness of the Ottawa rules. Other fractures include sacral insufficiency fractures, fractures of the femoral neck (especially if fracture is non-displaced and/or impacted), tibial plateau fracture, patellar, Lisfranc fractures of the metatarsals. Lower extremity fractures in children may suggest the possibility of child abuse.

Most fractures around the knee are easily detected on high-quality radiographs. However, some fractures and musculo-tendinous and ligamentous injuries have subtle findings and may be difficult to detect even with optimal images; these injuries include tibial plateau fractures, Segond fractures, stress fractures, fibular head fractures and dislocations, injuries to the patella and extensor mechanism and Saltzer type fractures. Clinically suspected tibial plateau fractures, unseen on standard views, may be seen on tangential or tunnel projections. Segond fractures usually have a characteristic appearance on anteroposterior radiographs but occasionally are seen only on tunnel views. Stress fractures of the proximal tibia may be accompanied by a vague band of increased sclerosis or endosteal callus on either side of the epiphyseal scar.

Correct diagnosis of fibular head dislocations requires clinical suspicion, since these injuries often are not recognised on initial radiographs. Careful evaluation of the congruity of the tibiofibular joint on the lateral projection is the key to diagnosis. Vertical patellar fractures are often non-displaced and are best evaluated with sunrise or Merchant views; avulsion fractures from the proximal or distal poles, with lateral views; and osteochondral fractures, with sunrise or internal oblique views. Saltzer injuries can be visualised on oblique and anteroposterior views obtained with stress applied to the knee. Some occult Saltzer I fractures are diagnosed on follow-up radiographs that show periosteal reaction. Imaging modalities other than radiography are rarely needed to diagnose fractures but are useful for evaluating the extent of displacement or confirming soft-
tissue injuries.

A normal sacrum seldom sustains an isolated fracture, though insufficiency fractures seen in postmenopausal women may be missed. In such cases, a bone scan or CT scan is a better diagnostic tool. Stress fractures of the metatarsal are not well defined on initial examination; over time, radiographs may demonstrate periosteal reaction cortical thickening/callus formation.

Avulsion fractures around the pelvic bones are sometimes subtle and are easily missed, especially if one is unaware of the site and mechanism of injury.

Impacted, undisplaced or incomplete femoral neck fractures may be virtually impossible to detect on plain films and may require MRI if the clinical suspicion is high. In young adults, slipped femoral capital epiphyses can be easily missed, especially if only one AP view is evaluated with out frog lateral radiographs.

Most ankle injuries are straightforward ligamentous injuries. However, the clinical presentation of subtle fractures can be similar to that of ankle sprains, and these fractures are frequently missed on initial examination. Fractures of the talus dome may be medial or lateral, and they are usually the result of inversion injuries, although medial injuries may be atraumatic. Lateral talar process fractures are characterised by point tenderness over the lateral process.

Posterior talar process fractures are often associated with tenderness to deep palpation anterior to the Achilles tendon over the posterolateral talus, and plantar flexion may exacerbate the pain. CT scans or magnetic resonance imaging may be required because these fractures are difficult to detect on plain films.

Practical points

1. Subtle non-displaced and hairline fractures may not be apparent at the time of injury.
2. Look for indirect signs – soft tissue swelling/obliteration or displacement of fat stripes/joint effusion/intracapsular fat-fluid level/double cortical line/buckling of cortex/irregular metaphyseal corners.
3. Unusual/metaphyseal corner fractures/multiple fractures can be due to non-accidental injury.
4. In the pelvis, because of the configuration of the bones, an apparently solitary fracture should not end the process of looking for other fractures.
5. Studies have shown a diurnal variation in errors of diagnosis (missing fractures) with a significant percentage errors being made in the evening and overnight.
6. If a radiologist makes an error of interpretation, the emergency doctors will not identify it.
7. The Royal College of Radiologists recommends that three minutes be spent on reporting each investigation.

References

**FIGURE 3a (left)**
Scaphoid fracture, high uptake, bone scan. Fracture was not seen on plain film.

**FIGURE 3b (below)**
Fracture of scaphoid; clearly visible on MRI.

**FIGURE 4**
Slipped femoral capital epiphyses, AP and frog leg projection. SCFE may not be visible on AP views.

**FIGURE 5**
Spiral undisplaced fracture of the tibia may be missed during “hot” reporting.